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## SECTION 400 -- ASPHALT PAVEMENTS

### SECTION 401 -- QUALITY CONTROL/QUALITY ASSURANCE, QC/QA, HOT MIX ASPHALT, HMA, PAVEMENT

**401.01 Description.** This work shall consist of one or more courses of QC/QA HMA base, intermediate, or surface mixtures constructed on prepared foundations in accordance with 105.03.

**401.02 Quality Control.** The HMA shall be supplied from a certified HMA plant in accordance with ITM 582; Certified Hot Mix Asphalt Producer Program. The HMA shall be transported and placed according to a Quality Control Plan, QCP, prepared and submitted by the Contractor in accordance with ITM 803; Contractor Quality Control Plans for Hot Mix Asphalt Pavements. The QCP shall be submitted to the Engineer at least 15 days prior to commencing HMA paving operations.

#### MATERIAL

**401.03 Materials.** Materials shall be in accordance with the following:

##### Asphalt Materials

PG Binder 902.01(a)

Coarse Aggregates ..... 904.02

Base Mixtures - Class D or Higher

Intermediate Mixtures - Class C or Higher

\* Surface Mixtures - Class B or Higher

Fine Aggregates (sand, mineral fillers) ..... 904.01

\* Surface aggregate requirements are listed in 904.02(d).

**401.04 Design Mix Formula.** A design mix formula, DMF, shall be prepared in accordance with 401.05 and submitted in a format acceptable to the Engineer one week prior to use. The DMF shall state the maximum particle size in the mixture. Approval of the DMF will be based on the ESAL and mixture designation. A mixture number will be assigned by the Engineer. No mixture will be accepted until the DMF has been approved.

**401.05 Volumetric Mix Design.** The DMF shall be determined for each mixture from a volumetric mix design by a design laboratory on the approved mix design laboratory list. A volumetric mixture shall be designed in accordance with the respective AASHTO references as listed below.

Standard Specification for Superpave

Volumetric Mix Design ..... AASHTO MP 2

Standard Practice for Short and Long Term

Aging of Hot Mix Asphalt (HMA) ..... AASHTO PP 2

Standard Practice for Volumetric Analysis of  
Compacted Hot Mix Asphalt (HMA)..... AASHTO PP 19

Standard Practice for Designing Superpave HM..... AAASHTO PP 28

Maximum Specific Gravity of Bituminous  
Paving Mixtures..... AASHTO T 209

Resistance of Compacted Bituminous Mixture to  
Moisture Induced Damage..... AASHTO T 283

Method for Preparing and Determining the  
Density of Hot Mix Asphalt (HMA)  
Specimens by Means of the SHRP  
Gyratory Compactor..... AASHTO TP 4

The single percentage of aggregate passing each required sieve shall be within the limits of the following gradation tables.

(a) Gradation Table for Design ESAL Equal To or Greater Than 10,000,000.

SIEVE SIZE	Nominal Maximum Particle Size - Control Point (Percent Passing)				
	*37.5 mm	*25.0 mm	*19.0 mm	*12.5 mm	*9.5 mm
50.0 mm	100.0				
37.5 mm	90.0 - 100.0	100.0			
25.0 mm	< 90.0	90.0 - 100.0	100.0		
19.0 mm		< 90.0	90.0 - 100.0	100.0	
12.5 mm			< 90.0	90.0 - 100.0	100.0
9.5 mm				< 90.0	90.0 - 100.0
4.75 mm	≤ 34.7	≤ 39.5			< 90.0
2.36 mm	15.0 - 23.3	19.0 - 26.8	23.0 - 34.6	28.0 - 39.1	32.0 - 47.2
1.18 mm	≤ 15.5	≤ 18.1	≤ 22.3	≤ 25.6	≤ 31.6
600 μm	≤ 11.7	≤ 13.6	≤ 16.7	≤ 19.1	≤ 23.5
300 μm	≤ 10.0	≤ 11.4	≤ 13.7	≤ 15.5	≤ 18.7
75 μm	0.0 - 6.0	1.0 - 7.0	2.0 - 8.0	2.0 - 10.0	2.0 - 10.0

\* Nominal Maximum Particle size - One sieve size larger than the first sieve to retain more than 10%.

**(b) Gradation Table for Design ESAL Less Than 10,000,000.**

	Nominal Maximum Particle Size - Control Point (Percent Passing)									
	*37.5 mm		*25.0 mm		*19.0 mm		*12.5 mm		*9.5 mm	
SIEVE SIZE										
50.0 mm	100.0									
37.5 mm	90.0 - 100.0		100.0							
25.0 mm	< 90.0		90.0 - 100.0		100.0					
19.0 mm			< 90.0		90.0 - 100.0		100.0			
12.5 mm					< 90.0		90.0 - 100.0		100.0	
9.5 mm							< 90.0		90.0 - 100.0	
Note 1	A	B	A	B	A	B	A	B	A	B
4.75 mm	≤ 34.7	≥ 34.7	≤ 39.5	≥ 39.5					< 90.0	< 90.0
2.36 mm	15.0 - 23.3	27.3 - 41.0	19.0 - 26.8	30.8 - 45.0	23.0 - 34.6	34.6 - 49.0	28.0 - 39.1	39.1 - 58.0	32.0 - 47.2	47.2 - 67.0
1.18 mm	≤ 15.5	≥ 21.5	≤ 18.1	≥ 24.1	≤ 22.3	≥ 28.3	≤ 25.6	≥ 31.6	≤ 31.6	≥ 37.6
600 μm	≤ 11.7	≥ 15.7	≤ 13.6	≥ 17.6	≤ 16.7	≥ 20.7	≤ 19.1	≥ 23.1	≤ 23.5	≥ 27.5
300 μm	≤ 10.0	≥ 10.0	≤ 11.4	≥ 11.4	≤ 13.7	≥ 13.7	≤ 15.5	≥ 15.5	≤ 18.7	≥ 18.7
75 μm	0.0 - 6.0		1.0 - 7.0		2.0 - 8.0		2.0 - 10.0		2.0 - 10.0	

70 \* Nominal Maximum Particle size - One sieve size larger than the first sieve to retain more than 10%.

NOTE 1: Either sub-column A or B shall be used consistently for 4.75 mm to 300 μm sieves.

Dust/Calculated Effective Binder Ratio shall be from 0.6 to 1.6. The optimum binder content shall produce 4.0% air voids at  $N_{des}$ . The design shall have at least four points, including a minimum of two points above and one point below the optimum. The amount of uncompacted mixture shall be determined in accordance with AASHTO T 209.

80 The mixture shall be tested for moisture susceptibility in accordance with AASHTO T 283 except that the loose mixture curing shall be replaced by short term aging for 2 h in accordance with AASHTO PP 2. The minimum tensile strength ratio, TSR, shall be 80%. The 150 mm (6 in.) mixture specimens shall be compacted in accordance with AASHTO TP 4. If anti-stripping additives are added to the mixture to be in accordance with the minimum TSR requirements, the dosage rate shall be submitted with the DMF.

Changes in the source or types of aggregates shall require a new DMF. A new DMF shall be submitted to the District Materials and Tests Engineer for approval one week prior to use.

90 Changes in the source of specified binders except for PG 58-28 or PG 64-22 shall require a new mix design.

The mixture design compaction temperature for the specimens shall be in accordance with the binder suppliers recommendations determined from a temperature - viscosity curve based on AASHTO TP 48.

Design criteria for each mixture shall be based on the ESAL shown in the contract documents and shall be as follows:

GYRATORY COMPACTION EFFORT					
ESAL	N <sub>ini</sub> *	N <sub>des</sub> *	N <sub>max</sub> *	Max. % Gmm @ N <sub>ini</sub>	Max. % Gmm @ N <sub>max</sub>
< 300,000	7	68	104	91.5	98.0
< 1,000,000	7	76	117	90.5	98.0
< 3,000,000	7	86	134	89.5	98.0
< 10,000,000	8	96	152	89.0	98.0
< 30,000,000	8	109	174	89.0	98.0
< 100,000,000	9	126	204	89.0	98.0
≥ 100,000,000	9	142	233	89.0	98.0

\* N<sub>ini</sub>, N<sub>des</sub>, N<sub>max</sub> - definitions are included in AASHTO PP 28.

VOIDS IN MINERAL AGGREGATE (VMA) CRITERIA @ N <sub>des</sub>	
Nominal Maximum Particle Size	Minimum VMA, Percent
9.5 mm	15.0
12.5 mm	14.0
19.0 mm	13.0
25.0 mm	12.0
37.5 mm	11.0

VOIDS FILLED WITH ASPHALT (VFA) CRITERIA @ N <sub>des</sub>	
ESAL	VFA, Percent
< 300,000	70 - 80
< 1,000,000	65 - 78
< 3,000,000	65 - 78
< 10,000,000	65 - 75
≥ 10,000,000	65 - 75

**401.06 Recycled Materials.** Recycled materials may consist of reclaimed asphalt pavement, RAP, or asphalt roofing shingles, ARS, or a blend of both. RAP shall be the product resulting from the cold milling or crushing of an existing HMA pavement. The RAP shall be processed so that 100% will pass the 50 mm (2 in.) sieve when entering the HMA plant. ARS shall consist of waste from a shingle manufacturing facility. No tear-off materials from roofs will be allowed. ARS shall be stockpiled separately from other materials. The coarse aggregate in the recycled materials shall pass the maximum size sieve for the mixture being produced.

Recycled materials may be used as a substitute for a portion of the new materials required to produce HMA mixtures. When only RAP is used in the mixture, the RAP shall not exceed 25% by mass (weight) of the total mixture. When only ARS is used in the mixture, the ARS shall not exceed 5% by mass (weight) of the total mixture. For substitution or use, 1% of ARS is considered equal to 5% RAP. The percentages of recycled materials shall be as specified on the DMF.

Mainline surface mixtures shall not contain recycled materials.

The combined aggregate properties of a mixture with recycled materials shall be determined in accordance with ITM 584 and shall be in accordance with 904.01 and 904.02. Gradations of the combined aggregates shall be in accordance with 401.05.

Mixtures containing 15% or less RAP, shall use the same grade of binder as specified. The binder for mixtures containing greater than 15% and up to 25% RAP shall be reduced by one temperature classification, 6°C, for both the upper and lower temperature classifications.

**401.07 Lots and Sublots.** Lots will be defined as 4000 Mg (4164 T) of base or intermediate mixtures or 2400 Mg (2500 T) of surface mixture. Lots will be further subdivided into sublots not to exceed 1000 Mg (1041 T) of base or intermediate mixtures or 600 Mg (624 T) of surface mixture. Partial sublots of 100 Mg (104 T) or less will be added to the previous sublot. Partial sublots greater than 100 Mg (104 T) constitute a full sublot.

**401.08 Job Mix Formula.** The job mix formula, JMF, shall be developed by a certified HMA producer in accordance with ITM 582. The JMF for each mixture shall be submitted to the Engineer.

**401.09 Acceptance of Mixtures.** Acceptance of mixtures for binder content, coarse aggregate angularity and gradation for each lot will be determined on the basis of extraction, coarse aggregate angularity and gradation tests performed by the Engineer. The Engineer will randomly select the location(s) within each sublot for sampling in accordance with the ITM 802.

One random sample shall be obtained from each sublot from the pavement in accordance with ITM 580. The test results of the sublots will be averaged and shall meet

150 the requirements for tolerances from the JMF for each sieve, coarse aggregate angularity, and binder content.

The maximum percent of moisture in the mixture shall not exceed 0.10 from plate samples.

The Engineer's acceptance test results will not be made available until a lot is completed and after the certified HMA plant's adjustment period.

ACCEPTANCE TOLERANCE FOR MIXTURES ( $\pm$ )										
MIXTURE	NUMBER OF TESTS	SIEVE SIZE								
		*37.5 mm	*25.0 mm	*19.0 mm	*12.5 mm	*9.5 mm	*4.75 mm	2.36 mm	600 $\mu$ m	75 $\mu$ m
BASE	1							10.0	6.0	2.0
	2							7.0	4.2	1.4
	3							5.8	3.5	1.2
	4							5.0	3.0	1.0
INTERMEDIATE	1							10.0	6.0	2.0
	2							7.0	4.2	1.4
	3							5.8	3.5	1.2
	4							5.0	3.0	1.0
SURFACE	1							8.0	4.0	1.0
	2							5.7	2.8	0.7
	3							4.6	2.3	0.6
	4							4.0	2.0	0.5

\* The acceptance tolerance for this sieve shall be the applicable composition limits specified in 401.05.

160

ACCEPTANCE TOLERANCE FOR BINDER				
BASE, INTERMEDIATE, OR SURFACE MIXTURES				
Binder Content	Number of Tests			
	1	2	3	4
% Binder	0.7	0.5	0.4	0.3

Acceptance of mixtures for range will be determined using the subplot test results of the extraction and gradation tests from each lot. If the range is not in accordance with the requirements, adjustment points will be assessed in accordance with 401.19(a).

ACCEPTANCE TOLERANCE FOR RANGE ( $\pm$ )			
SIEVE SIZE & BINDER CONTENT	PERCENTAGE POINTS		
	BASE	INTERMEDIATE	SURFACE
2.36 mm	15.0	15.0	12.0
600 $\mu$ m	9.0	9.0	6.0
75 $\mu$ m	3.0	3.0	1.5
% BINDER	1.0	1.0	1.0

Acceptance tolerance for coarse aggregate angularity shall be minus 5% of the value as shown on the JMF.

170 Acceptance tolerances for binder content, gradation, and coarse aggregate angularity will be as set out above for the number of tests performed. The acceptance tolerance for range will be as set out above for lots of more than one subplot. The range of binder shall be the difference between the highest subplot binder content and the lowest subplot binder content in one lot. The range of gradation shall be the difference between the highest subplot percent passing and the lowest subplot percent passing each required sieve in one lot.

Single test values and averages will be reported to the nearest 0.1%. Rounding will be in accordance with ASTM E 29.

180 Lot adjustment points will be assessed in accordance with 401.19(a) when the average or range for binder content, coarse aggregate angularity, or gradation are not met.

The Contractor may request an appeal of the Engineer's test results in accordance with 401.20.

## CONSTRUCTION REQUIREMENTS

**401.10 General.** Equipment for HMA operations shall be in accordance with 408.

190 Fuel oil, kerosene, or solvents shall not be transported in open containers on equipment. Cleaning of equipment and small tools shall not be accomplished on the pavement or shoulder areas.

Segregation, flushing or bleeding of HMA mixtures will not be permitted. Corrective action shall be taken to prevent continuation of these conditions. Segregated,



flushed or bleeding HMA mixtures shall be removed if directed. All areas showing an excess or deficiency of binder shall be removed and replaced.

200 All mixtures that become loose and broken, mixed with dirt, or is in any way defective shall be removed and replaced.

**401.11 Preparation of Surfaces to be Overlaid.** The subgrade shall be shaped to the required grade and sections, free from all ruts, corrugations, or other irregularities, and uniformly compacted and approved in accordance with 207. Surfaces on which a mixture is placed shall be free from objectionable or foreign materials at the time of placement.

210 Compacted aggregate bases and rubblized pavements shall be primed in accordance with 405. Portland cement concrete and asphalt surfaces shall be tacked in accordance with 406. Contact surfaces of curbing, gutters, manholes, and other structures shall be tacked in accordance with 406.

**401.12 Process Control.** The Engineer and Contractor will jointly review the operations to ensure compliance with the QCP. Continuous violations of compliance with the QCP will result in suspension of paving operations.

**401.13 Weather Limitations.** HMA courses of 75 kg/m<sup>2</sup> (138 lb/sq yd) or less shall be placed when the ambient temperature and the temperature of the surface on which it is to be placed is 7°C (45°F) or above. No mixture shall be placed on a frozen subgrade.

220 **401.14 Spreading and Finishing.** The mixture shall be placed upon an approved surface by means of a paver or other mechanical devices in accordance with 408.03. Mixtures in areas inaccessible to mechanical devices may be placed by other methods.

The temperature of each mixture at the time of spreading, shall not be more than 10°C (18°F) below the minimum mixing temperature as shown on the JMF.

230 HMA courses greater than 90 kg/m<sup>2</sup> (165 lb/sq yd) placed under traffic, shall be brought up even with each adjacent lane at the end of each work day. HMA courses less than or equal to 90 kg/m<sup>2</sup> (165 lb/sq yd) shall be brought forward concurrently, within practical limits, limiting the work in one lane to not more than one work day of production before moving back to bring forward the adjacent lane. Traffic shall not be allowed on Base C50.0 mm, Base C25.0 mm, or Intermediate C19.0 mm mixtures.

Hydraulic extensions on the paver will not be permitted for continuous paving operations. Fixed extensions or extendable screeds shall be used on courses greater than the nominal width of the paver except in areas where the paving widths vary. Hydraulic extensions may be used in tapers and added lanes less than 75 m (250 ft) in length.

240 Automatic slope and grade controls shall be required as outlined in the QCP.

HMA shoulders which are 2.4 m (8.0 ft) or more in width shall be placed with automatic paving equipment.

When laying mixtures with density controlled by 401.16(c), the speed of the paver shall not exceed 15 m (50 ft) per min.

The rollers shall be operated to avoid shoving of the HMA and at speeds not to exceed 4.5 km/h (3 mph). However, vibratory rollers will be limited to 4 km/h (2.5 mph).

250 The finished depth of any course shall be a minimum of 1.5 times and a maximum of three times the maximum particle size as shown on the DMF.

**401.15 Joints.** Longitudinal joints in the surface shall be at the lanelines of the pavement. Longitudinal joints below the surface shall be offset from previously constructed joints by approximately 150 mm (6 in.), and be located within 300 mm (12 in.) of the lane line.

260 Transverse joints shall be constructed by exposing a near vertical full depth face of the previous course. For areas inaccessible to rollers, other mechanical devices shall be used to achieve the required density.

If constructed under traffic, temporary transverse joints shall be feathered to provide a smooth transition to the driving surface.

270 **401.16 Density.** The type of density acceptance method for all QC/QA mainline mixtures shall be determined by the number of mainline ESAL. Density of the compacted mixture shall be accepted by using cores when the ESAL are equal to or greater than 10,000,000 in accordance with 401.16(a). Nuclear testing devices shall be used when the ESAL are equal to or greater than 3,000,000 and less than 10,000,000 in accordance with 401.16(b). Standard rolling pattern practices shall be used when the ESAL are less than 3,000,000 in accordance with 401.16(c).

The type of density acceptance method for all QC/QA mixtures on shoulders, shall be determined by the number of mainline ESAL, except as follows:

- 280
- (a) for total planned shoulder typical sections less than 180 kg/m<sup>2</sup> (330 lb/sq yd), density shall be controlled by 401.16(c);
  - (b) for total planned shoulder typical sections equal to or greater than 180 kg/m<sup>2</sup> (330 lb/sq yd), density of the first lift shall be controlled by 401.16(c); and
  - (c) density testing of the top lift will not be taken within the area of formed shoulder corrugations.

The Engineer's acceptance test results will not be made available until a lot is completed.

Sublot and lot density values will be reported to the nearest 0.1%. Rounding will be in accordance with ASTM E 29.

290           **(a) Mainline ESAL Equal To or Greater Than 10,000,000.** Acceptance for density for all QC/QA mixtures shall be based on cores cut from the compacted pavement and analysis of samples obtained in accordance with 401.09. Acceptance will be based on lots and sublots in accordance with 401.07. The Engineer will randomly select two locations in accordance with ITM 802, within each sublot for testing. The transverse core location will be located so that the edge of the core will be no closer than 75 mm (3 in.) from a confined edge or 150 mm (6 in.) from a non-confined edge of the course being placed.

300           The Contractor shall obtain cores in the presence of the Engineer with a device that shall produce a uniform 150 mm (6 in.) diameter pavement sample. Sublot coring shall be completed prior to the random location being covered. Surface courses shall be cored within one work day of placement. Damaged core(s) shall be discarded and replaced with a core from a location selected by adding 0.3 m (1.0 ft) to the longitudinal location of the damaged core using the same transverse offset.

              The Contractor and the Engineer shall mark the core to define the course to be tested. If the core indicates a course thickness of less than 1.5 times the maximum particle size, the core will be discarded and a core from a new random location will be selected for testing.

310           The Engineer will take immediate possession of the cores. If the Engineer's cores are subsequently damaged, additional coring within a specific sublot or sublots will be the responsibility of the Department. Subsequent core locations will be determined by subtracting 0.3 m (1.0 ft) from the random location using the same transverse offset. Appeal core(s) if required, will be taken within 0.3 m (1.0 ft) of the analyzed core(s) using the same transverse offset.

320           The density of the sublot for the mixture shall be expressed as the percentage of maximum specific gravity (%MSG) obtained by dividing the average bulk specific gravity for the sublot by the maximum specific gravity for the sublot, times 100. The Engineer will determine the bulk specific gravity of the cores in accordance with AASHTO T 166 or T 275, and the maximum specific gravity in accordance with AASHTO T 209 from plant produced materials.

              The densities of the sublots will be averaged to determine the density of the lot.

              Within one work day of coring operations the Contractor shall clean, dry, and refill the core holes with suitable materials. The Contractor's plan for refilling core holes shall be outlined in the QCP.

330           **(b) Mainline ESAL Equal To or Greater Than 3,000,000 and Less Than 10,000,000.** Acceptance for density for QC/QA mixtures shall be based on nuclear testing on the compacted pavement.

Acceptance will be based on lots in accordance with 401.07. The lots will be divided into sublots of 1600 m<sup>2</sup> (2,000 sq yd) each for the pavement and shoulders. Each lot shall have a minimum of one subplot. The target density shall be determined from a test strip constructed in accordance with ITM 577. The target density shall be not less than 96.0% of the unit weight of the mixture at the optimum binder content at N<sub>des</sub> determined from the mix design. A separate test strip will be required on each course placed on the pavement and each course placed on the shoulder. The Engineer may determine the uniformity of compaction by taking cores. An additional test strip may be requested by the Contractor or Engineer.

The density for each subplot will be the average of five tests taken at a random station in accordance with ITM 802. When the width of pavement does not allow tests to be taken transversely, the five tests shall be taken longitudinally. No test will be taken closer than 0.3 m (1.0 ft) to the edge of the course. If an individual subplot falls below 98.0% of target density, another randomly selected site within the subplot will be tested. These two test results will be averaged for the subplot density. The densities of the sublots will be averaged to determine the average density of the lot.

Within one work day of coring operations the Contractor shall clean, dry, and refill the core holes with suitable materials. The Contractor's plan for refilling core holes shall be outlined in the QCP.

**(c) Mainline ESAL Less Than 3,000,000.** Density requirements for the compacted mixture shall be controlled in accordance with 402.10 and 402.13.

**401.17 Shoulder Corrugations.** HMA shoulders shall have formed or milled corrugations, if specified in the plans.

**(a) Formed Corrugations.** Formed corrugations consist of formed depressions in newly constructed surface mixtures for shoulders. The corrugations shall be formed by means of a roller modified with a pipe welded to the drum and equipped with guides to maintain the proper offset and alignment of the strips or as approved by the Engineer. The roller shall be in accordance with 408.03(d).

**(b) Milled Corrugations.** Milled corrugations consist of cutting smooth strips in existing or newly constructed shoulders. The operation shall be conducted without affecting traffic operations, by means of a cutting machine that provides a series of smooth cuts without tearing or snagging. The equipment shall include guides to maintain uniformity and consistency in the alignment of the strips.

The operation shall be coordinated such that milled materials do not encroach on pavement lanes carrying traffic and all milled materials are disposed of in accordance with 104.07.

**401.18 Pavement Smoothness.** The pavement smoothness will be accepted by means of a profilograph, a 4.9 m (16 ft) long straightedge, or a 3 m (10 ft) long straightedge.

The profilograph shall be used on all full width pavement lanes of 75 m (250 ft) or longer, where the HMA to be placed is 180 kg/m<sup>2</sup> (330 lb/sq yd) or greater, and having a design speed of greater than 70 km/h (45 mph), unless otherwise specified.

If a pay item, Profilograph, is included in the contract, the Contractor shall furnish, calibrate, and operate an approved profilograph in accordance with ITM 901. The profilogram produced shall become the property of the Department. The profilograph shall remain the property of the Contractor. When a profilograph is not included as a pay item, the Department will furnish, calibrate, and operate the profilograph.

The 4.9 m (16 ft) long straightedge shall be used on all full width pavement lanes shorter than 75 m (250 ft), tapers, within 15 m (50 ft) of bridge ends, and within 15 m (50 ft) of an existing pavement which is being joined. It shall be used on resurface overlays of less than 180 kg/m<sup>2</sup> (330 lb/sq yd).

The 3 m (10 ft) long straightedge shall be used for transverse slopes, approaches, and crossovers.

Pavement smoothness requirements will not apply to single course overlay work unless it is preceded by milling. All wavelike irregularities and abrupt changes in profile of single course nonmilled surface caused by paving operations shall be corrected.

Each finished course of base and intermediate shall be subject to approval. The pavement smoothness shall be checked on the surface course and a new course placed immediately below the surface course at the locations as designated in ITM 901.

Pavement smoothness variations shall be corrected to comply with the smoothness requirements in the following table. If grinding of the intermediate course is used for pavement smoothness corrections, the grinding shall not precede the surface placement by more than 30 calendar days if open to traffic.

PAVEMENT SURFACE TOLERANCES	
Testing Method	Specified Tolerance
Profilograph Design speeds greater than 70 km/h (45 mph)  Design speeds 70 km/h (45 mph) or less	30 mm/0.16 km (1.2 in./0.1 mi) profile index or less  41 mm/0.16 km (1.6 in./0.1 mi) profile index or less
4.9 m (16 ft) Straightedge All pavements	6 mm (1/4 in.) or less
3 m (10 ft) Straightedge Base & Intermediates Surface	6 mm (1/4 in.) or less 3 mm (1/8 in.) or less

When the profilograph is being used on a surface course, in addition to the requirements for the profile index, all areas having a high point deviation in excess of 8 mm (0.3 in.) shall be corrected. Courses underlying the surface course that are exposed by corrective actions shall be milled to 25 mm (1 in.) and replaced with surface materials. Verifying profilograph measurements will be taken only in the 0.16 km (0.1 mi) length where corrections have been performed to reduce the profile index.

When the profilograph is being used on an intermediate course, all areas having a high point deviation in excess of 8 mm (0.3 in.) shall be corrected. When the 4.9 m (16 ft) or 3.0 m (10 ft) straightedge is being used on an intermediate course, all areas having a high point deviation in excess of 6 mm (0.2 in.) shall be corrected.

**401.19 Adjustment Points.** When test results for mixture properties, density, and smoothness exceed the allowable tolerances, adjustment points will be assessed. The adjustment points will be used to calculate a quality assurance adjustment quantity (q) for the lot.

The adjustment for mixture properties and density are calculated as follows.

$$q = L \times U \times P/100$$

where:

q = quality assurance adjustment quantity

L = lot quantity

U = unit price for the material, \$/Mg (\$/TON)

P = total adjustment points

The quality assurance adjustment points for smoothness will be calculated in accordance with 401.19(c).

The total quality assurance adjustments is to be calculated as follows:

$$Q = Q_s + \sum (q_m + q_d)$$

where:

Q = total quality assurance adjustment quantity

Q<sub>s</sub> = quality assurance adjustment for smoothness as calculated in 401.19(c)

q<sub>m</sub> = lot adjustments for mixtures

q<sub>d</sub> = lot adjustments for density

If the total adjustment points for a lot are greater than 15, the pavement will be evaluated by the Materials and Tests Division. If the Contractor is not required to remove the mixture, quality assurance adjustments of the lot will be assessed or other corrective actions as determined by the Materials and Tests Division.

**(a) Mixture.** When test results for the mixture furnished exceed the allowable tolerances, adjustment points will be assessed as follows:

ADJUSTMENT POINTS FOR GRADATION									
Adjustment Points	SIEVE SIZE								
	37.5 mm	25.0 mm	19.0 mm	12.5 mm	9.5 mm	4.75 mm	2.36 mm	600 μm	75 μm
For Each 0.1% up to 1.0% Out Of Tolerance	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.3
For Each 0.1% > 1.0 Out of Tolerance	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.3	0.6

Gradation adjustment points for the lot shall be the sum of points calculated for up to 1% out of tolerance and the points calculated for greater than 1% out of tolerance in accordance with 401.09.

Coarse aggregate angularity adjustment points for the lot shall be 0.2 points for each 0.1% out of tolerance in accordance with 401.09.

Binder content adjustment points for the lot shall be two points for each 0.1% above the tolerance or four points for each 0.1% below the tolerance in accordance with 401.09.

When test results for the mixture furnished exceed the allowable range in accordance with 401.09, adjustment points will be assessed as follows:

ADJUSTMENT POINTS FOR RANGE	
Sieve Size & Binder Content	Adjustment Points (For Each 0.1% Out Of Range)
2.36 mm	0.1
600 μm	0.1
75 μm	0.1
% Binder	1.0

For mixtures produced during a certified HMA plant's adjustment period, adjustment points will not be assessed if the mixture produced is in accordance with the following.

1. The gradation complies with 401.05 with the allowable tolerance limits shown in 401.09.
2. The range for the binder content and gradation do not exceed the limits shown in 401.09.
3. The coarse aggregate angularity is in accordance with the minimum requirements of 904.02(c).

4. The binder content is within the tolerance requirements of 401.09.

If the mixture is not in accordance with these requirements, adjustment points will be assessed in accordance with 401.09 for variations exceeding the requirements shown above.

(b) **Density.** When the density of the lot is outside the allowable tolerances, adjustment points will be assessed as follows:

500

**1. Mainline ESAL Equal To or Greater Than 10,000,000.**

Pay Adjustments - Percent	For Thickness of Base & Intermediate $\geq$ 37.5 mm (1.5 in.) and all Surfaces Mixes	For Thickness of Intermediate Mixes < 37.5 mm (1.5 in.)
	Percentages are based on % MSG	
submitted to the Materials and Tests Division for disposition	$\geq$ 97.0	$\geq$ 97.0
1.0 points for each 0.1 % above 96.0	96.0 - 96.9	96.0 - 96.9
100	92.0 - 95.9	91.0 - 95.9
0.05 points for each 0.1 % below 92.0/91.0	91.0 - 91.9	90.0 - 90.9
0.5 + 0.4 points for each 0.1 % below 91.0/90.0	90.0 - 90.9	89.0 - 89.9
4.5 + 1.0 points for each 0.1 % below 90.0/89.0	88.0 - 89.9 See Note 1	87.0 - 88.9 See Note 1
submitted to the Materials and Tests Division for disposition	$\leq$ 87.9 See Note 1	$\leq$ 86.9 See Note 1

Note 1: If two consecutive lots fall within this range, the Contractor shall stop production of the mix, identify an action plan to address the deficiencies, and submit an addendum to the QCP.

**2. Mainline ESAL Equal To or Greater Than 3,000,000 and Less Than 10,000,000.** If the average density of a subplot is less than 95.0% of the target density, adjustment points will be assessed to the lot containing the subplot. The assessment will be 0.1 points for each 0.1% below 95.0%.

If the average density of the lot is less than 98.0% of the target density, adjustment points will be assessed in accordance with the following:

510



Pay Adjustments	Percent (%)
None	≥ 98.0
0.5 points for each 0.1 % below 98.0	96.0 - 97.9
10.0 + 1.0 points for each 0.1 % below 96.0	≤ 95.9

(c) **Smoothness.** When the pavement smoothness is tested with a profilograph, payment will be based on the profile index in accordance with the following table. Quality assurance adjustments for smoothness will apply to the planned typical section including the aggregate base, and the HMA base, intermediate, and surface courses. The quality assurance adjustment for each section will include the total area of each 0.16 km (0.1 mi) long section represented by the profile index calculated by the following formula:

520

$$q_s = \frac{P}{100} \sum_{i=1}^n A \times \frac{S}{1000} \times U$$

where:

$q_s$  = quality assurance adjustment for smoothness for one section

P = adjustment points

N = number of layers

A = area of the section, m<sup>2</sup> (Syd)

S = spread rate for material, kg/m<sup>2</sup> (lb/syd)

530

U = unit price for the material, \$/Mg (\$/Ton)

The quality assurance adjustment for smoothness,  $Q_s$ , for the contract will be the total of the quality assurance adjustments for smoothness,  $q_s$ , on each section.

ADJUSTMENT FOR SMOOTHNESS			
Design Speed Greater Than 70 km/h (45 mph)		Design Speed Less Than Or Equal to 70 km/h (45 mph)	
Final Profile Index mm per 0.16 km (in./0.1 mi)	Adjustment Points	Final Profile Index mm per 0.16 km (in./0.1 mi)	Adjustment Points
0 to 30 mm (0.0 to 1.2)	None	0 to 41 mm (0.0 to 1.6)	None
over 30 to 33 mm (1.2 to 1.3)	2.0	over 41 to 46 mm (1.6 to 1.8)	2.0
over 33 to 36 mm (1.3 to 1.4)	4.0	over 46 to 51 mm (1.8 to 2.0)	4.0
over 36 to 38 mm (1.4 to 1.5)	8.0	over 51 to 56 mm (2.0 to 2.2)	8.0
All pavement with a profile index greater than 38 mm (1.5) shall be corrected.		All pavement with a profile index greater than 56 mm (2.2) shall be corrected.	

**401.20 Appeals.** If the Contractor does not agree with the acceptance test results, a request may be made in writing for additional tests for a subplot(s) or lot. The basis of the appeal shall include applicable QC test results showing acceptable quality results and shall be submitted within five calendar days of receipt of the Department's written results for that lot. All traffic control shall be supplied with no additional payment.

**(a) Mixture.** Upon approval for the additional testing, the Contractor shall take cores in accordance with ITM 580.

**(b) Density.**

**1. Mainline ESAL Equal To or Greater Than 10,000,000.** If an appeal is granted, additional cores shall be taken within five calendar days unless otherwise directed. Additional core locations will be within 0.3 m (1.0 ft) longitudinally of the cores tested using the same transverse offset. Each subplot density will be calculated using the average bulk specific gravity of the cores obtained for that subplot and the average MSG of the lot.

The results of the appeal cores will replace the initial test results for a subplot(s) or lot and be used as the basis for acceptance in accordance with 401.16(a).

**2. Mainline ESAL Equal To or Greater Than 3,000,000 and Less Than 10,000,000.** Sublots below 95% density may be appealed. Upon approval of the appeal for additional testing, the Contractor shall take one core 150 mm (6 in.) in diameter from each of the randomly selected sites with a transverse location determined in accordance

with ITM 802 within five calendar days unless otherwise directed. The test results of these cores will be averaged for the density of the subplot. Adjustment points will be assessed in accordance with 401.19(b)2 to the lot containing the subplot. The Engineer may, however, order removal and replacement of the subplot.

570 Lots below 98% density may be appealed. Upon approval of the appeal for additional testing, the Contractor shall take one core 150 mm (6 in.) in diameter from each of the randomly selected sites with a transverse location determined in accordance with ITM 802 within five calendar days unless otherwise directed. The test results of these cores will be averaged for the density of the lot. Adjustment points will be assessed in accordance with 401.19(b)2.

**401.21 Method of Measurement.** HMA mixtures will be measured by the megagram (ton) of the type specified, in accordance with 109.01(b).

580 HMA mass (weight) measured may vary from the proposal quantities because of possible variation in aggregate specific gravity. No adjustment in contract unit price will be made because of such variation, except for slag as provided in 904.02(a).

580 Milled shoulder corrugations will be measured by the meter (linear foot) of shoulder milled, measured parallel to the center line of the roadway. Formed shoulder corrugations will not be measured.

**401.22 Basis of Payment.** The accepted quantities for this work will be paid for at the contract unit price per megagram (ton) for QC/QA-HMA, of the type specified, complete in place.

590 Payment for furnishing, calibrating, and operating the profilograph, and furnishing profile information will be made at the contract lump sum price for profilograph.

Adjustments to the contract payment with respect to mixture, density, and smoothness for mixture produced will be included in a quality assurance adjustment pay item. The unit price for this pay item will be one dollar (\$1.00) and the quantity will be in negative units of dollars. The quantity is the total calculated in accordance with 401.19. An extra work order developed in accordance with 109.05 will be prepared to reflect contract adjustments.

600 Milled corrugations will be paid for at the contract unit price per meter (linear foot), when specified.

Payment will be made under:

Pay Item	Metric Pay Unit Symbol (English Pay Unit Symbol)
QC/QA-HMA Surface <u>  </u> mm, Mainline.....	Mg (TON)
QC/QA-HMA Intermediate <u>  </u> mm, Mainline.....	Mg (TON)
QC/QA-HMA Base <u>  </u> mm, Mainline .....	Mg (TON)

610	QC/QA-HMA Surface <u>    </u> * mm, Shoulder.....	Mg (TON)
	QC/QA-HMA Intermediate <u>    </u> * mm, Shoulder.....	Mg (TON)
	QC/QA-HMA Base <u>    </u> * mm, Shoulder .....	Mg (TON)
	Quality Assurance Adjustment .....	DOL
	Milled HMA Corrugations .....	m (LFT)
	Profilograph .....	LS

\* Nominal Maximum Particle Size

Preparation of surfaces to be overlaid shall be included in the costs of other pay items.

620           Coring and refilling of the pavement holes shall be included in the costs of other pay items.

No payments will be made for additional anti-stripping additives, appeal coring or related traffic control expenditures for coring operations.

The cost of incorporating formed corrugations in HMA shoulders shall be included in the costs of other pay items.

630           Corrections for pavement smoothness shall be included in the costs of other pay items.

The price for profilograph will be full compensation regardless of how often the profilograph is used or how many profilograms are produced.

640           If QC/QA-HMA intermediate over QC/QA-HMA base mixtures are specified, QC/QA-HMA Intermediate 19.0 mm will be permitted as a substitute for the QC/QA-HMA intermediate and QC/QA-HMA base mixtures upon a written request by the Contractor. The request for the substitution shall be prepared in advance of the work. A computation will be made in order to obtain a unit price for the QC/QA-HMA Intermediate 19.0 mm. The quantity and amount for QC/QA-HMA Intermediate 19.0 mm shall equal the sum of the contract quantities and amounts shown for QC/QA-HMA Intermediate and QC/QA-HMA base mixtures. The unit price for QC/QA-HMA Intermediate 19.0 mm shall be equal to the sum of contract amounts divided by the sum of contract quantities. Payment for the QC/QA-HMA Intermediate 19.0 mm will be made at the unit price per megagram (ton) for QC/QA-HMA Intermediate 19.0 mm. No payment will be made for additional work or costs which may result due to this change.

## SECTION 402 -- HOT MIX ASPHALT, HMA, PAVEMENT

**402.01 Description.** This work shall consist of one or more courses of HMA base, intermediate, or surface mixtures and miscellaneous courses for rumble strips, and wedge and leveling constructed on prepared foundations in accordance with 105.03.

## MATERIALS

**402.02 Materials.** Materials shall be in accordance with the following:

**Asphalt Materials**

PG Binder, PG 64-22, PG 58-28\* .....902.01(a)

Asphalt Emulsions, AE-60, AE-90\* .....902.01(b)

Coarse Aggregates .....904.02

Base Mixtures - Class D or Higher

Intermediate Mixtures - Class C or Higher

\*\* Surface Mixtures - Class B or Higher

Fine Aggregates (sand, mineral fillers) .....904.01

\* Only for use in mixtures containing greater than 15% RAP. Refer to 402.05.

\*\* Surface aggregate requirements are listed in 904.02(d).

**402.03 Job Mix Formula.** The job mix formula, JMF, shall be prepared in accordance with 402.04 or shall be an approved JMF in accordance with 401.08 of the same gyratory compaction effort ESAL category or one category higher, and submitted in a format acceptable to the Engineer. The JMF shall state the maximum particle size in the mixture. Approval of the JMF will be based on the ESAL and mixture designation. A mixture number will be assigned by the Engineer. No mixture will be accepted until the JMF has been approved.

All changes in the type or source of aggregate, or in the type of binder shall require the submittal of a new JMF for approval.

**402.04 Mix Criteria.** The JMF shall be based on the limits shown in the following tables for the percent passing the 2.36 mm (No. 8) sieve and the percent of binder.

The percent of aggregates passing sieves specified in the mixture composition tables below is a percentage of the total mass (weight) of aggregates. The percent of binder specified in the mixture composition tables below is a percentage of the total mass (weight) of mixture.

When 100% slag is used for the coarse aggregate, the binder content shall be increased 0.4% when using blast furnace slag, and decreased by 0.7% when using steel slag. When blending coarse aggregate slag, proportional changes in the binder content shall be made.

**(a) Composition Limits for Base Mixtures.**

Sieve Size	Percent of Aggregates Passing Sieves Sizes		
	Mixture		
	C50.0 mm	C25.0 mm	25.0 mm
63.0 mm (2.5 in.)	100.0		
37.5 mm (1.5 in.)	45.0-75.0	100.0	100.0
25.0 mm (1 in.)	30.0-60.0	70.0-98.0	90.0-99.0
19.0 mm (3/4 in.)	20.0-50.0	50.0-85.0	< 90.0
12.5 mm (1/2 in.)	15.0-40.0	28.0-62.0	
9.5 mm (3/8 in.)	10.0-35.0	15.0-50.0	
4.75 mm (No. 4)	5.0-25.0	6.0-29.0	
2.36 mm (No. 8)	12.0 ± 6.0	12.0 ± 6.0	23.0 ± 6.0
1.18 mm (No. 16)	2.0-15.0	2.0-15.0	
600 μm (No. 30)	1.0-10.0	1.0-10.0	
300 μm (No. 50)	0.0-7.0	0.0-7.0	
150 μm (No. 100)	0.0-6.0	0.0-6.0	
75 μm (No. 200)	0.0-4.0	0.0-4.0	1.0-7.0
Percent of Binder	3.0	3.2	4.5

**(b) Composition Limits for Intermediate Mixtures.**

Sieve Size	Percent of Aggregates Passing Sieve Sizes			
	Mixture			
	19.0 mm	C19.0 mm	12.5 mm	9.5 mm
25.0 mm (1 in.)	100.0	100.0		
19.0 mm (3/4 in.)	90.0-99	70.0-98.0	100.0	
12.5 mm (1/2 in.)	< 90.0	40.0-68.0	90.0-100.0	100.0
9.5 mm (3/8 in.)		20.0-52.0	< 90.0	90.0-100.0
4.75 mm (No. 4)		10.0-20.0		< 90.0
2.36 mm (No. 8)	29.0 ± 6.0	12.0 ± 6.0	33.0 ± 6.0	39.0 ± 6.0
1.18 mm (No. 16)		2.0-15.0		
600 μm (No. 30)		1.0-10.0		
300 μm (No. 50)		0.0-7.0		
150 μm (No. 100)		0.0-6.0		
75 μm (No. 200)	2.0-8.0	0.0-4.0	2.0-10.0	2.0-10.0
Percent of Binder	4.8	3.2	4.9	5.1

**(c) Composition Limits for Surface Mixtures.**

Sieve Size	Percent of Aggregates Passing Sieve Sizes			
	Mixture			
	19.0 mm	12.5 mm	9.5 mm	4.75 mm*
25.0 mm (1 in.)	100.0			
19.0 mm (3/4 in.)	90.0-100.0	100.0		
12.5 mm (1/2 in.)	< 90.0	90.0-100.0	100.0	
9.5 mm (3/8 in.)		< 90.0	90.0-100.0	100.0
4.75 mm (No. 4)			< 90.0	95.0-100.0
2.36 mm (No. 8)	42.0 ± 6.0	48.0 ± 6.0	57.0 ± 6.0	70.0-90.0
1.18 mm (No. 16)				40.0-68.0
600 µm (No. 30)				20.0-50.0
300 µm (No. 50)				7.0-30.0
150 µm (No. 100)				1.0-20.0
75 µm (No. 200)	2.0-6.0	2.0-6.0	2.0-6.0	0.0-5.0
Percent of Binder	5.5	5.7	6.1	7.0-8.0

\* The fineness modulus shall be greater than 2.80 as determined in accordance with ASTM C 136.

**(d) Composition Limits for HMA Rumble Strip Mixtures.** Rumble strip mixtures shall be in accordance with HMA Surface 9.5 mm or HMA Surface 4.75 mm. Mixture adjustments in accordance with 904.02(a) do not apply. Aggregate requirements of 904.02(d) do not apply.

**(e) Composition Limits for HMA Wedge and Leveling Mixtures.** The mixture shall consist of HMA mixes in accordance with 402.04(a), (b), or (c).

**402.05 Recycled Materials.** Recycled materials may consist of reclaimed asphalt pavement, RAP, or asphalt roofing shingles, ARS, or a blend of both. RAP shall be the product resulting from the cold milling or crushing of an existing HMA pavement. The RAP shall be processed so that 100% will pass the 50 mm (2 in.) sieve when entering the HMA plant. ARS shall consist of waste from a shingle manufacturing facility. No tear-off materials from roofs will be allowed. ARS shall be stockpiled separately from other materials. The coarse aggregate in the recycled materials shall pass the maximum size sieve for the mixture being produced.

Recycled materials may be used as a substitute for a portion of the new materials required to produce HMA mixtures. When only RAP is used in the mixture, the RAP shall not exceed 25% by mass (weight) of the total mixture. When only ARS is used in the mixture, the ARS shall not exceed 5% by mass (weight) of the total mixture. For substitution or use, 1% of ARS is considered equal to 5% RAP. The percentages of recycled materials shall be as specified on the JMF.



Mainline surface mixtures shall not contain recycled materials.

80 The combined aggregate properties of a mixture with recycled materials shall be determined in accordance with ITM 584 and shall be in accordance with 904.01 and 904.02. Gradations of the combined aggregates shall be in accordance with 402.03.

Mixtures containing 15% or less RAP, the asphalt materials shall be PG 64-22 or AE-60. Mixtures containing greater than 15 and up to 25% RAP, the grade of asphalt material shall be PG 58-28 or AE-90.

90 **402.06 Acceptance of Mixtures.** Sampling of the HMA mixture will be in accordance with ITM 580 and performed where deemed necessary. Acceptance of the mixtures for binder content and gradations will be determined based on extractions in accordance with ITM 571 and coarse aggregate angularity in accordance with 904.02(c). Testing will be performed by the Engineer in accordance with the Frequency Manual.

When mixtures in accordance with 401.08 are substituted for mixtures as permitted in 402.03, gradation acceptance tolerances will be based on the following:

ACCEPTANCE TOLERANCE FOR MIXTURES ( $\pm$ )									
MIXTURE	SIEVE SIZE								
	37.5 mm*	25.0 mm*	19.0 mm*	12.5 mm*	9.5 mm*	4.75 mm*	2.36 mm	600 $\mu$ m	75 $\mu$ m
Base							10.0	6.0	2.0
Intermediate							10.0	6.0	2.0
Surface							8.0	4.0	1.0

\* The acceptance tolerance for this sieve shall be the applicable composition limits specified in 401.05.

100 Gradation test results which are outside the composition limits will be considered and adjudicated as a failed material in accordance with normal Department practice as listed in 105.03.

Asphalt test results which are more than  $\pm 0.5\%$  from the JMF will be considered as a failed material and adjudicated in accordance with normal Department practice as listed in 105.03.

110 **402.07 Preparation of Mixtures.** Mixtures shall consist of coarse aggregate, fine aggregate, and asphalt material combined in proportions within the limits set out in the JMF.

The mixture shall be prepared by a HMA mixing plant in accordance with 408.02. All aggregates shall be sufficiently dried such that foaming, flushing, or slumping does not occur in the mix. The maximum percent of moisture in the mixture shall not exceed 0.10 from plate samples.

The temperature of the finished mixture at the plant, except for mixtures designated as C mixtures, shall be within the following limits:

BINDER *	TEMPERATURE RANGES, °C (°F)	
	Minimum	Maximum
PG Grade	125° (260°)	150° (300°)
AE Grade	110° (230°)	150° (300°)

The temperature of the finished mixture at the plant, for mixtures designated as C mixtures, shall be within the following limits:

BINDER *	TEMPERATURE RANGES, °C (°F)	
	Minimum	Maximum
PG Grade	95° (200°)	115° (250°)
AE Grade	80° (180°)	115° (250°)

\* A draindown test in accordance with ITM 585 will be completed for Base C50.0 mm, Base C25.0 mm, and Intermediate C19.0 mm mixtures.

Binder draindown shall not exceed 0.5% for Base C50.0 mm, Base C25.0 mm, and Intermediate C190.0 mm mixtures.

## CONSTRUCTION REQUIREMENTS

**402.08 General.** Equipment for HMA operations shall be in accordance with 408.

Fuel oil, kerosene, or solvents shall not be transported in open containers on any equipment at any time. Cleaning of equipment and tools shall not be accomplished on the pavement or shoulder areas.

Segregation, flushing or bleeding of HMA mixtures will not be permitted. Corrective action shall be taken to prevent continuation of these conditions. Areas of segregation, flushing or bleeding shall be corrected, if directed. All areas showing an excess or deficiency of asphalt materials shall be removed and replaced.

All mixtures that become loose and broken, mixed with dirt, or is in any way defective shall be removed and replaced.

Mixture shall not be dispatched from the plant that cannot be spread and compacted before sundown of that day, unless otherwise permitted.

**402.09 Preparation of Surfaces to be Overlaid.** The subgrade shall be shaped to the required grade and sections, free from all ruts, corrugations, or other irregularities, and uniformly compacted and approved in accordance with 207. Surfaces on which a mixture is placed shall be free from objectionable or foreign materials at the time of placement.

Compacted aggregate bases and rubblized pavements shall be primed in accordance with 405. Portland cement concrete and asphalt surfaces shall be tacked in accordance with 406. Contact surfaces of curbing, gutters, manholes, and other structures shall be tacked in accordance with 406.

**402.10 Weather Limitations.** HMA courses less than 60 kg/m<sup>2</sup> (110 lb/sq yd) are to be placed when the ambient and surface temperatures are 16°C (60°F) or above. HMA courses equal to or greater than 60 kg/m<sup>2</sup> (110 lb/sq yd) but less 120 kg/m<sup>2</sup> (220 lb/sq yd) are to be placed when the ambient and surface temperatures are 7°C (45°F) or above. HMA courses equal to or greater than 120 kg/m<sup>2</sup> (220 lb/sq yd) and HMA curbing are to be placed when the ambient and surface temperatures are 0°C (32°F) or above. No mixture shall be placed on a frozen subgrade. However, HMA courses may be placed at lower temperatures, provided the density of the HMA course is in accordance with 402.14.

HMA base and intermediate courses open to traffic from December 1 through March 31 shall be sealed prior to suspension of work or within seven work days as directed by the Engineer. The seal coat shall be a type 1 seal coat in accordance with 404. Temperature requirements of 404.04 do not apply.

All partially completed sections of roadway that are 200 mm (8 in.) or less in thickness shall be proofrolled prior to the placement of additional materials the following spring. Proofrolling shall be accomplished in accordance with 203.26. The contact pressure shall be 480 to 550 kPa (70 to 80 psi). Soft yielding areas shall be removed and replaced.

**402.11 Spreading and Finishing.** The mixture shall be placed upon an approved surface by means of laydown equipment in accordance with 408.03(c). Mixtures in areas inaccessible to laydown equipment or mechanical devices may be placed by other methods.

The temperature of each mixture at the time of spreading, shall not be more than 10°C (18°F) below the minimum mixing temperature as shown in 402.07.

HMA courses greater than 90 kg/m<sup>2</sup> (165 lb/sq yd) placed under traffic, shall be brought up even with each adjacent lane at the end of each work day. HMA courses less than or equal to 90 kg/m<sup>2</sup> (165 lb/sq yd) shall be brought forward concurrently, within practical limits, limiting the work in one lane to not more than one work day of production before moving back to bring forward the adjacent lane. Traffic shall not be allowed on Base C50.0 mm, Base C25.0 mm, or Intermediate C19.0 mm mixtures.

Hydraulic extensions on the paver will not be permitted for continuous paving operations. Fixed extensions or extendable screeds shall be used on courses greater than the nominal width of the paver except in areas where the paving widths vary. Hydraulic extensions may be used on approaches, tapers, and added lanes less than 75 m (250 ft) in length.

HMA shoulders which are 2.4 m (8.0 ft) or more shall be placed with automatic paving equipment.

200 HMA mixtures in hauling equipment shall be protected by tarps from adverse weather conditions or foreign materials. Adverse weather conditions include but will not be limited to precipitation or temperatures below 7°C (45°F).

The speed of the paver shall not exceed 15 m (50 ft) per min when spreading mixtures.

210 Automatic slope and grade controls shall be required except when placing mixtures on roadway approaches which are less than 60 m (200 ft) in length, less than 60 kg/m<sup>2</sup> (110 lb/sq yd) HMA courses, or on miscellaneous work. The use of automatic controls on other courses where use is impractical due to project conditions may be waived by the Engineer.

The finished depth of each course shall be a minimum of 1.5 times and a maximum of three times the maximum particle size in accordance with 402.04. The maximum particle size shall be the smallest sieve size that passes 100% of the aggregates. Scratch courses and feathering of mixtures may be less than the minimum depth requirements.

220 Rumble strips shall be spread so as to ensure uniformity of depth, width, texture, and the required spacing between strips. A tack coat in accordance with 406 shall be applied on the pavement surface prior to placing the mixture. The tack coat may be applied with a paint brush or other approved methods.

HMA mixtures for approaches or wedge and leveling with planned depths less than 75 mm (3 in.), may be constructed with multiple surface courses in accordance with 402.04.

230 **402.12 Joints.** Longitudinal joints in the surface shall be at the lanelines of the pavement. Longitudinal joints below the surface shall be offset from previously constructed joints by approximately 150 mm (6 in.), and be located within 300 mm (12 in.) of the laneline.

Transverse joints shall be constructed by exposing a near vertical full depth face of the previous course.

If constructed under traffic, temporary transverse joints shall be feathered to provide a smooth transition to the driving surface.

240 **402.13 Compaction.** The HMA mixture shall be compacted with equipment in accordance with 408.03(d) immediately after the mixture has been spread and finished. Rollers shall not cause undue displacement, cracking, or shoving.

A roller application is defined as one pass of the roller over the entire mat. Compaction operations shall be completed in accordance with one of the following options:

Number of Roller Applications				
Rollers	Courses $\leq 180 \text{ kg/m}^2$ (330 lb/sq yd)			Courses $> 180 \text{ kg/m}^2$ (330 lb/ sq yd)
	Option 1	Option 2	Option 3	
Three Wheel*	2		4	4
Pneumatic Tire	2	4		4
Tandem	2	2	2	4

\* A three wheel roller is required on all HMA 4.75 mm surface course.

Option 4: For courses  $\leq 180 \text{ kg/m}^2$  (330 lb/sq yd), compaction may be completed utilizing vibratory rollers in accordance with the Department's Approved Equipment List - Vibratory Rollers.

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A reduced number of applications on a course may be approved if detrimental results are being observed.

Compaction equipment shall be operated with the drive roll or wheels nearest the paver and at speeds not to exceed 4.5 km/h (3 mph). However, vibratory rollers will be limited to 4 km/h (2.5 mph). Rolling shall be continued until applications are completed and all roller marks are eliminated.

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Compaction operations shall begin at the low side and proceed to the high side of the mat. The heaviest roller wheel shall overlap its previous pass by a minimum of 150 mm (6 in.).

Longitudinal joints shall be compacted by making the first pass to the paver with the compaction equipment on the hot mat about 150 mm (6 in.) from the longitudinal joint. On the return pass, the compaction equipment shall overlap the longitudinal joint 150 mm (6 in.) where possible.

270

All displacement of the HMA mixture shall be corrected at once by the use of lutes and/or the addition of fresh mixture as required. The line and grade of the edges of the HMA mixture shall not be displaced during rolling.

The wheels shall be kept properly moistened with water or water with detergent to prevent adhesion of the materials to the wheels.

Areas inaccessible to rollers shall be compacted thoroughly with hand tampers or other mechanical devices in accordance with 408.03(d)6 to achieve the required compaction. A trench roller, in accordance with 408.03(d)5, may be used to obtain compaction in depressed areas.

280 All rolling operations shall be completed before the temperature of mixtures with PG Binder drops below 80°C (180°F) or the temperature of mixtures with AE Binder drops below 60°C (145°F).

Vehicular traffic will not be permitted on a course until the mixture has cooled sufficiently to prevent distortions.

Rumble strips shall be compacted with vibratory compacting equipment in accordance with 408.03(d)6 unless otherwise stated.

290 **402.14 Low Temperature Density Requirements.** Compaction for mixtures placed below the temperatures listed in 402.10, shall be controlled by air voids determined from cores cut from the compacted pavement placed during a low temperature period. Acceptance will be based on a minimum of two cores per section. Sections are defined as a maximum of 1000 Mg (1041 T) of HMA base or intermediate or 600 Mg (624 T) of HMA surface. The Engineer will randomly select locations in accordance with ITM 802. The transverse core location will be located so that the edge of the core will be no closer than 75 mm (3 in.) from a confined edge or 150 mm (6 in.) from a non-confined edge of the course being placed.

300 For compaction of HMA during low temperature periods with quantities less than 100 Mg (104 T) per day, acceptance may be visual.

The Contractor shall obtain cores in the presence of the Engineer with a device that shall produce a uniform 150 mm (6 in) diameter pavement sample. Coring shall be completed prior to the random location being covered. The final HMA course shall be cored within one work day of placement. Damaged core(s) shall be discarded and replaced with a core from a location selected by adding 0.3 m (1.0 ft) to the longitudinal location of the damaged core using the same transverse offset.

310 The Contractor, in the presence of the Engineer, shall mark the core to define the course to be tested. If the defined area is less than 1.5 times the maximum particle size, the core will be discarded and a core from a new random location will be selected for testing.

The Engineer will take immediate possession of the cores. If the Engineer's cores are subsequently damaged, additional coring within a specific section will be the responsibility of the Department. Subsequent core locations will be determined by subtracting 0.3 m (1.0 ft) from the random location using the same transverse offset.

320 The percent air voids of a section for the mixture shall be expressed as:

$$AV \% = ( 1.0 - BSG/MSG ) \times 100$$

where:

$$AV \% = \text{percent air voids}$$

BSG = average bulk specific gravity  
MSG = maximum specific gravity

330 The Engineer will determine the bulk specific gravity of the cores in accordance with AASHTO T 166 or AASHTO T 275, and the maximum specific gravity in accordance with AASHTO T 209 from the first mixture sample of the day. Air voids shall not be greater than 8%. Within one work day of coring operations, the Contractor shall clean, dry, refill, and compact the core holes with suitable materials.

**402.15 Shoulder Corrugations.** HMA shoulders shall have formed or milled corrugations, if specified in the plans.

340 (a) **Formed Corrugations.** Formed corrugations consist of formed depressions in newly constructed surface mixtures for shoulders. The corrugations shall be formed by a roller modified with a pipe welded to the drum and equipped with guides to maintain the proper offset and alignment of the strips or as approved by the Engineer. The roller shall meet the requirements of 408.03(d).

Density of the compacted HMA shoulders shall meet the requirements of 402.13.

350 (b) **Milled Corrugations.** Milled corrugations consist of cutting smooth strips in existing or newly constructed shoulders. The operation shall be conducted without affecting traffic operations by a cutting machine that provides a series of smooth cuts without tearing or snagging. The equipment shall include guides to maintain uniformity and consistency in the alignment of the strips.

The operation shall be coordinated such that milled materials do not encroach on pavement lanes carrying traffic and all milled materials are disposed of in accordance with 104.07.

**402.16 Pavement Smoothness.** The pavement smoothness will be verified by means of a 4.9 m (16 ft) long straightedge on pavement lanes and a 3 m (10 ft) long straightedge for transverse slopes, approaches, and crossovers.

360 Pavement smoothness requirements will not apply to single course overlay work unless it is preceded by milling. All wavelike irregularities and abrupt changes in profile of single course nonmilled surfaces caused by paving operations, shall be corrected.

Pavement smoothness tolerances shall be 6 mm (1/4 in.) except for surface courses checked with a 3 m (10 ft) straightedge the tolerances shall be 3 mm (1/8 in.). Areas outside the allowable tolerance may be corrected by grinding with a grooved type cutter. An alternate method for correcting the profile may be approved. Milling of the surface to correct variations will not be permitted.

370 **402.17 Method of Measurement.** HMA mixtures will be measured by the megagram (ton) of the type specified, in accordance with 109.01(b).

HMA rumble strips will be measured by the meter (linear foot) of each transverse strip, complete in place.

Milled shoulder corrugations will be measured in accordance with 401.21. Formed shoulder corrugations will not be measured.

380        **402.18 Basis of Payment.** The accepted quantities for this work will be paid for at the contract unit price per megagram (ton) for HMA, of the type specified complete in place.

HMA rumble strips will be paid for at the contract unit price per meter (linear foot), of each transverse strip complete in place.

The cost of milled shoulder corrugations will be paid for in accordance with 401.22.

Payment will be made under:

390	<b>Pay Item</b>	<b>Metric Pay Unit Symbol (English Pay Unit Symbol)</b>
	HMA Surface * mm, Mainline .....	Mg (TON)
	HMA Intermediate * mm, Mainline .....	Mg (TON)
	HMA Base * mm, Mainline .....	Mg (TON)
	HMA Surface * mm, Shoulder .....	Mg (TON)
	HMA Intermediate * mm, Shoulder .....	Mg (TON)
	HMA Base * mm, Shoulder .....	Mg (TON)
	HMA Rumble Strips .....	m (LFT)
	HMA Wedge and Level .....	Mg (TON)

400

\* Nominal Maximum Particle Size

Preparation of surfaces to be overlaid shall be included in the costs of other pay items.

No payment will be made for additional anti-stripping additives.

410        The cost of seal coat type 1 necessary for maintaining traffic on HMA base and intermediate courses from December 1 through March 31 shall be included in the costs of other pay items.

The cost of removing and replacing soft yielding areas discovered by proofrolling shall be included in the costs of other pay items.

No payment will be made for coring operations and related traffic control expenditures required in 402.14.

420        The cost of incorporating formed corrugations in HMA shoulders shall be included in the costs of other pay items.



Corrections for pavement smoothness including removal and replacement of pavement, shall be included in the costs of other pay items.

HMA mass (weight) measured may vary from the proposal quantities because of possible variation in aggregate specific gravity. No adjustment in contract unit price will be made because of such variation, except for slag as provided in 904.02(a).

The costs of furnishing all equipment, materials, placing and all incidentals related to HMA rumble strips, or HMA wedge and level mixtures shall be included in the cost of the specific pay item.

If HMA intermediate over HMA base mixtures are specified, HMA Intermediate 19.0 mm will be permitted as a substitute for the HMA intermediate and HMA base mixtures upon a written request by the Contractor. The request for the substitution shall be prepared in advance of the work. A computation will be made in order to obtain a unit price for the HMA Intermediate 19.0 mm. The quantity and amount for HMA Intermediate 19.0 mm shall equal the sum of the contract quantities and amounts shown for HMA intermediate and HMA base mixtures. The unit price for HMA Intermediate 19.0 mm shall be equal to the sum of contract amounts divided by the sum of contract quantities. Payment for the HMA Intermediate 19.0 mm will be made at the unit price per megagram (ton) for HMA Intermediate 19.0 mm. No payment will be made for additional work or costs which may result due to this change.

## SECTION 403 -- COLD MIX ASPHALT, CMA, PAVEMENT

**403.01 Description.** This work shall consist of the construction of one or more courses of CMA base, intermediate, or surface for immediate use or stockpiled in accordance with 105.03.

### MATERIALS

**403.02 Materials.** Materials shall be in accordance with the following:

#### Asphalt Materials

For Immediate Use,

Asphalt Emulsion AE-150, AE-90 .....902.01(b)

For Stockpiling, Asphalt Emulsion, AE-150 .....902.01(b)

#### Coarse Aggregates

Base, Class D or Higher .....904.02

Intermediate, Class C or Higher .....904.02

Surface, Class B or Higher .....904.02

Fine Aggregates (sand, mineral filler) .....904.01

### CONSTRUCTION REQUIREMENTS

**403.03 Weather Limitations.** CMA pavements shall not be placed on a wet surface, when the ambient temperature is below 4°C (40°F), or when other unsuitable conditions exist, unless approved by the Engineer.

**403.04 Equipment.** Mixing plant, hauling trucks, pavers, and rollers shall be in accordance with 408.

30 **403.05 Preparation of Mixtures.** The size of the aggregate and the grade of asphalt materials shall be as specified. The gradations and percent of asphalt shall be as follows:

Composition Limits for CMA Mixtures						
Sieve Size	Total Percent of Aggregates Passing Sieves Based on Total Mass (Weight) of Aggregates					
	Size 2	Size 5	Size 8	Size 9	Size 11	Size 5D
63 mm (2.5 in.)	100					
50 mm (2 in.)	95-100					
37.5 mm (1.5 in.)		100				100
25.0 mm (1 in.)	0-25	85-100	100			80-99
19.0 mm (3/4 in.)	0-10	60-90	75-100	100		68-90
12.5 mm (1/2 in.)	0-7	30-65	40-75	65-90	100	54-76
9.5 mm (3/8 in.)		15-50	20-55	30-65	75-100	45-67
4.75 mm (No. 4)		0-20	0-20	0-20	10-35	30-50
2.36 mm (No. 8)		0-15	0-15	0-15	0-15	20-45
600 µm (No. 30)						7-28
75 µm (No. 200)	0-5	0-5	0-5	0-6	0-6	0-6
Minimum Percent Crushed	95	95	95	95	95	95
Percent of Asphalt*	2.0-3.5	2.5-4.0	3.0-4.5	3.5-5.0	4.0-6.0	3.5-5.0

\* Percent of asphalt shall be calculated on the basis of the total mass (weight) of the mixture, exclusive of water or solvent. When slag is used, the asphalt content will be adjusted to compensate for the specific gravity and surface area.

The moisture condition of the aggregate shall be such that the aggregate is uniformly coated and satisfactorily retains the required amount of asphalt during the stockpiling, hauling, and spreading operations. Mixtures shall not be produced at temperatures exceeding 80°C (180°F).

40 **403.06 Preparation of Subgrade or Base.** Mixtures for CMA base may be placed on an earth subgrade, on an existing pavement surface to be used as a base, or on a previously prepared base or subbase as specified, and shall conform to the lines, grades, and cross sections shown on the plans or as otherwise specified. If such material is to be laid on a newly prepared subgrade, then all applicable requirements of 207 shall apply.

**403.07 Spreading Mixture.** The CMA mixture shall be spread in accordance with 402.11.

**403.08 Curing.** All CMA mixtures shall be allowed to cure sufficiently to prevent undue distortions under the roller wheels.

When a CMA mixture is allowed to cure under traffic, the surface shall be maintained and all damaged areas shall be satisfactorily repaired.

**403.09 Compaction.** Compaction shall be in accordance with 402.13. Satisfactory means to confine the mixture within the required limits shall be in place during the compaction operation.

**403.10 Surface Tolerances.** The smoothness requirements for CMA pavements shall be in accordance with 402.16.

**403.11 Method of Measurement.** CMA pavement will be measured by the megagram (ton), of the type and size specified, in accordance with 109.01(b).

**403.12 Basis of Payment.** The accepted quantities of CMA pavement will be paid for at the contract unit price per megagram (ton), of the type and size specified, for the mixture.

Payment will be made under:

Pay Item	Metric Pay Unit Symbol (English Pay Unit Symbol)
CMA Base _____ size	Mg (TON)
CMA Intermediate _____ size	Mg (TON)
CMA Surface _____ size	Mg (TON)

The cost of repairing damaged areas of mixture allowed to cure under traffic shall be included in the costs of the pay items.

## SECTION 404 -- SEAL COAT

**404.01 Description.** This work shall consist of one or more applications of asphalt material, each followed by an application of cover aggregate in accordance with 105.03.

### MATERIALS

**404.02 Asphalt Material.** The type and grade of asphalt material shall in accordance with the following:

Asphalt Emulsion, RS-2, AE-90,  
AE-150 or HFRS-2 .....902.01(b)

**404.03 Cover Aggregate.** Aggregate shall be in accordance with the following requirements. When slag is used as an alternate to natural aggregate, adjustments will be made in accordance with 904.02(a), to compensate for differences in specific gravity.

Coarse Aggregates, Class B or Higher  
Size No. 8, 9, 11, or 12 .....904.02

Fine Aggregate  
Size No. 23 or 24 .....904.01

20

The types of seal coats shall be as follows:

TYPE	APPLICATION	COVER AGGREGATE SIZE NO.	RATES OF APPLICATION PER SQUARE METER (SQUARE YARD)	
			AGGREGATE kg (lb)	ASPHALT MATERIAL LITER (GALLON) AT 16°C (60°F)
1*	Single	23,24	5.4-6.8 (12-15)	0.45-0.61 (0.12-0.16)
2	Single	12	6.4-7.7 (14-17)	1.09-1.25 (0.29-0.33)
3	Single	11	7.3-9.1 (16-20)	1.36-1.51 (0.36-0.40)
4	Single	9	12.7-14.5 (28-32)	2.38-2.57 (0.63-0.68)
5	Double	a. 11 b. 12	7.3-9.1 (16-20) 7.3-8.6 (16-19)	1.36-1.51 (0.36-0.40) 1.25-1.40 (0.33-0.37)
6	Double	a. 9 b. 11	12.7-14.5 (28-32) 8.2-10.0 (18-22)	2.38-2.57 (0.63-0.68) 1.55-1.74 (0.41-0.46)
7	Double	a. 8 b. 11	12.7-14.5 (28-32) 8.2-10.0 (18-22)	2.38-2.57 (0.63-0.68) 1.55-1.74 (0.41-0.46)

\* Only AE-90 or AE-150 shall be used for seal coat, type 1.

## CONSTRUCTION REQUIREMENTS

30        **404.04 Weather Limitations.** Asphalt material shall not be applied on a wet surface, or when other weather conditions would adversely affect the seal coats. Seal coats shall not be placed when the ambient or base temperature is below 4°C (40°F). If seal coats are placed when the ambient or base temperature is between 4°C (40°F) and 16°C (60°F), the cover aggregate shall be heated to between 49°C (120° F) and 66°C (150°F).

**404.05 Equipment.** A distributor, rotary power broom, pneumatic tire roller, and aggregate spreader in accordance with 408.03, shall be used.

40        **404.06 Preparation of Surface.** Surfaces to be sealed shall be brought to proper section and grade, compacted, cleaned as required, and approved. Aggregate surfaces to be sealed shall be primed in accordance with 406.

**404.07 Applying Asphalt Material.** Asphalt material shall be applied in a uniform continuous spread over the section to be treated. The quantity of asphalt material to be applied per square meter (square yard) shall be as directed.

          The asphalt material shall not be spread over a greater area than that which can be covered with the cover aggregate that is in trucks at the site. It shall not be spread more than 150 m (500 ft) ahead of the aggregate spreader.

50        The spread of the asphalt material shall be no wider than the width covered by the cover aggregate from the spreading device. Operations shall not proceed such that asphalt material is allowed to chill, set up, dry, or otherwise impair retention of the cover coat.

**404.08 Application of Cover Aggregate.** Immediately following the application of the asphalt material, cover aggregate shall be spread in quantities as directed. Spreading shall be accomplished such that the tires of the trucks or aggregate spreader do not contact the uncovered and newly applied asphalt material.

60        Rolling shall consist of at least three complete roller coverages and be completed within 30 min after the cover aggregate is applied. The rollers shall not be operated at speeds which will displace the cover aggregate from the asphalt material.

          The seal coat shall be protected by the restriction of traffic or by controlling traffic speed until the asphalt material has cured or set sufficiently to hold the cover aggregate without displacement.

          Excess cover aggregate shall be removed from the pavement surface by light brooming on the day following placement of the seal coat. The brooming shall not displace the imbedded cover aggregate.

**404.09 Method of Measurement.** Asphalt material and cover aggregate will be measured by the megagram (ton). Seal coat will be measured by the square meter (square yard).

If measurement of seal coat is made by the square meter (square yard), the quantity for each day's placement will be the least of the following:

- (a) the measured square meters (square yards) within the specified limits;
- 80 (b) the calculated square meters (square yards) based on the amount of aggregate used, divided by the minimum amount of aggregate per square meter (square yard) specified in 404.03; or
- (c) the calculated square meters (square yards) based on the amount of asphalt material used, divided by the minimum amount of asphalt material per square meter (square yard) specified in 404.03.

90 **404.10 Basis of Payment.** The accepted quantities of asphalt material and cover aggregate will be paid for at the contract unit price per megagram (ton). Seal coat will be paid for at the contract unit price per square meter (square yard) complete in place. If steel slag is used as a cover aggregate, and payment will be made per megagram (ton), the pay quantity will be adjusted in accordance with 904.02(a).

If seal coat is paid for by the square meter (square yard) and if so directed, asphalt material in excess of the limits set out in 404.03 will be paid for at the Contractor's invoice price, plus 20%.

Payment will be made under:

100	<b>Pay Item</b>	<b>Metric Pay Unit Symbol (English Pay Unit Symbol)</b>
	Asphalt for Seal Coat.....	Mg (TON)
	Cover Aggregate, Seal Coat.....	Mg (TON)
	Seal Coat, _____	m2 (SYS)
	type	

## SECTION 405 -- PRIME COAT

**405.01 Description.** This work shall consist of preparing and treating an existing or newly constructed aggregate surface with asphalt material and cover aggregate in accordance with 105.03.

## MATERIALS

10 **405.02 Asphalt Material.** The type and grade of asphalt material shall be in accordance with the following:

Asphalt Emulsion, AE-P or AE-PL.....	902.01(b)
Cut-Back Asphalt, MC-70.....	902.01(c)

**405.03 Cover Aggregate.** Aggregate shall be in accordance with the following:

Coarse Aggregate, Class B or Higher, Size No. 12 .....	904.02
Fine Aggregate, Size No. 23 or 24 .....	904.01

20

## CONSTRUCTION REQUIREMENTS

**405.04 Weather Limitations.** Asphalt material shall not be applied on a wet surface, when the ambient temperature is below 10°C (50°F), or when other unsuitable conditions exist, unless approved by the Engineer.

**405.05 Equipment.** A distributor and aggregate spreader in accordance with 408.03 shall be used.

30      **405.06 Preparation of Surface.** The existing surface to be treated shall be shaped to the required grade and section; free from all ruts, corrugations, or other irregularities; uniformly compacted; and approved.

**405.07 Application of Asphalt Material.** The asphalt material shall be uniformly applied at the rate of 1.1 to 3.6 L/m<sup>2</sup> (0.25 to 0.80 gal./sq yd) in a continuous spread over the section to be treated or as directed.

40      When traffic is to be maintained within the limits of the section, approximately half of the width of the section shall be treated in one application. Complete coverage of the section shall be ensured. Treated areas shall not be opened to traffic until the asphalt material has been absorbed.

**405.08 Cover Aggregate.** If the asphalt material fails to penetrate and the primed surface must be used by traffic, cover aggregate shall be spread to provide a dry surface.

**405.09 Method of Measurement.** Asphalt for prime coat will be measured by the megagram (ton), or by the square meter (square yard). Cover aggregate will be measured by the megagram (ton).

50      **405.10 Basis of Payment.** The accepted quantities of prime coat will be paid for at the contract unit price per megagram (ton), or per square meter (square yard) for asphalt for prime coat. The accepted quantities of cover aggregate will be paid for at the contract unit price per megagram (ton), complete in place.

Payment will be made under:

Pay Item	Metric Pay Unit Symbol (English Pay Unit Symbol)
----------	--

Asphalt for Prime Coat .....	Mg (TON)
	m2 (SYS)
Cover Aggregate, Prime Coat .....	Mg (Ton)

## SECTION 406 -- TACK COAT

**406.01 Description.** This work shall consist of preparing and treating an existing pavement or concrete surface with asphalt material in accordance with 105.03.

## MATERIALS

**406.02 Asphalt Material.** The type and grade of asphalt material shall be in accordance with the following:

Asphalt Emulsion, AE-T .....	902.04(b)
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## CONSTRUCTION REQUIREMENTS

**406.03 Equipment.** A distributor in accordance with 408.03(a) shall be used.

**406.04 Preparation of Surface.** The existing surface to be treated shall be free of foreign materials deemed detrimental by the Engineer.

**406.05 Application of Asphalt Material.** The asphalt material shall be uniformly applied at the rate of from 0.14 to 0.36 L/m<sup>2</sup> (0.03 to 0.08 gal./sq yd), or as otherwise specified or directed.

Tack coat shall not be applied to a wet surface. The rate of application, temperature, and areas to be treated shall be approved prior to application. Excessive tack coat shall be corrected to obtain an even distribution.

**406.06 Method of Measurement.** Asphalt for tack coat will be measured by the megagram (ton) or by the square meter (square yard).

**406.07 Basis of Payment.** The accepted quantities of tack coat will be paid for at the contract unit price per megagram (ton), or per square meter (square yard) for asphalt for tack coat, complete in place.

Payment will be made under:

Pay Item	Metric Pay Unit Symbol (English Pay Unit Symbol)
----------	--

Asphalt for Tack Coat.....	Mg (TON)
	m2 (SYS)



## SECTION 407 -- DUST PALATIVE

**407.01 Description.** This work shall consist of preparing and treating an existing aggregate surface with asphalt material in accordance with 105.03.

### MATERIALS

**407.02 Asphalt Material.** The type and grade of asphalt material shall be in accordance with the following:

10

Asphalt Emulsion, AE-PL.....902.01(b)

### CONSTRUCTION REQUIREMENTS

**407.03 Weather Limitations.** Asphalt material shall not be applied on a wet surface, when the ambient temperature is below 10°C (50°F), or when other unsuitable conditions exist, unless approved by the Engineer.

20

**407.04 Equipment.** A distributor in accordance with 408.03(a) shall be used.

**407.05 Preparation of Surface.** The surface to be treated shall be shaped to the required section, and be free from all ruts, corrugations, or other irregularities.

**407.06 Application of Asphalt Material.** The asphalt material shall be uniformly applied at the rate of 1.5 to 5 L/m<sup>2</sup> (0.25 to 1.00 gal./sq yd) in a uniform continuous spread over the section to be treated or as directed.

30

When traffic is to be maintained within the limits of the section, approximately half of the width of the section shall be treated in one application. Complete coverage of the section shall be ensured. Treated areas shall not be opened to traffic until the asphalt material has been absorbed.

**407.07 Method of Measurement.** Asphalt for dust palative will be measured by the megagram (ton).

**407.08 Basis of Payment.** The accepted quantities of this work will be paid for at the contract unit price per megagram (ton) for asphalt for dust palative, complete in place.

Payment will be made under:

40

Pay Item	Metric Pay Unit Symbol (English Pay Unit Symbol)
Asphalt for Dust Palative .....	Mg (TON)

## SECTION 408 -- EQUIPMENT

**408.01 Production, Transportation, and Laydown of Asphalt Mixtures.** For production of asphalt mixtures, the Contractor shall provide all equipment necessary for the production, transportation, and laydown operations.

**408.02 Mixing Plant.** The mixing plant shall be capable of producing a uniform mixture.

10                   **(a) HMA Mixing Plant.**

1. **Plant Inspection.** A plant inspection in accordance with 106.03 will be made by the Engineer annually, after a plant is moved, or as deemed necessary.

2. **Proportioning Systems.** All meters, scales, and other measuring devices shall be accurate to within  $\pm 0.5\%$  throughout their range unless otherwise approved.

20                   **3. Material Storage.**

a. **Aggregates.** The aggregate storage area shall be well drained. All stockpiles shall be sufficiently separated and identified by signs or other approved methods.

b. **Asphalt.** The storage, circulation, and delivery system shall be equipped to maintain the asphalt materials utilizing the recommendations of the asphalt materials supplier. Each system shall be equipped with a sampling device to obtain a representative asphalt sample. An armored thermometer or pyrometer having a minimum range of 20° to 200°C (70° to 400°F), readable to 2°C (5°F), shall be installed in each storage tank. An open flame shall not come into direct contact with the tank being heated.

30 All line valves shall have clear and permanent markings to indicate the open and closed positions. Each storage tank shall be labeled to identify the grade of asphalt.

4. **Aggregate Feed System.** The minimum number of compartments in the cold aggregate feed system shall be equal to the number of individual materials to be used in the mixture. The aggregate compartments shall be designed to prevent overflow of material from one compartment into another. The feeder of each compartment shall be capable of proportioning the aggregates. A scalper, or other device, shall be provided to remove oversize particles from the blended aggregates.

40                   5. **Drier Unit.** The drier unit shall be capable of drying and heating aggregates. The unit shall be equipped with a device that continuously records the discharge temperature of the material. Daily recording charts shall be kept at the plant site and shall be accessible at all times until the project is accepted.

6. **Dust Collector.** The dust collector system shall comply with all applicable laws, ordinances, and regulations regarding emissions. If dust is to be returned into the HMA, the system shall return the materials at a constant rate during production.

50 7. **Mixing Unit.** The mixing unit shall be capable of producing uniformly coated and graded mixtures at the specified temperatures.

8. **Mix Load-out Scales.** Scales or automatic systems shall be in accordance with 109.01(b).

60 For a contract with asphalt mixture quantities of 4500 Mg (5000 T) or more, a load, selected at random, will be checked on an independent commercial scale during the first day of production, and thereafter as directed. The gross mass (weight) of the check load and tare mass (weight) of the truck over the same scale, and the net mass (weight) of the mixture shall be recorded on a ticket which is attached to the print-out ticket and retained in the file of the Engineer. The net mass (weight) of mixture in the check load shall not vary from the total mass (weight) of mixture recorded on the printout tickets by more than 90 kg (200 lb) for loads up to 9 Mg (10 T); 135 kg (300 lb) for loads from 9 Mg to 13.6 Mg (10 to 15 T); or 180 kg (400 lb) for loads over 13.6 Mg (15 T). Results outside of these tolerances shall be investigated.

9. **Hot Surge Bins.** A hot surge bin may be used to minimize interruptions during normal production.

70 The bin(s) shall be equipped with a low-level indicator and cut-off system to stop the discharge when the mix falls below the top of the cone. The cut-off system may be automatic or manual. The manual system shall have an audio alarm to notify the operator when to stop the discharge. Approval in accordance with ITM 578 is required for surge bin(s) to be used for extended storage.

10. **Sampling Point Requirements.** Adequate points shall be provided where required to sample materials for testing and acceptance.

#### (b) CMA Mixing Plant.

80 The mixing plant shall be of sufficient capacity and coordination to adequately handle the proposed CMA construction. The mixing unit shall be a twin shaft pugmill or other approved mixer, including the drum type capable of producing a consistent uniform mixture. The outlet of the mixer shall be such that it prevents segregation of the material when discharged.

A HMA mixing plant in accordance with 408.02(a) may be utilized as a CMA mixing plant.

#### 408.03 HMA Laydown Operations.

90

**(a) Distributor.** The distributor shall be equipped, maintained, and operated to provide uniform heating and application rates as specified. The distributor shall have a volume measuring device and a thermometer to monitor the asphalt material.

Distributors shall also be equipped with a power unit for the pump and with a full circulation spray bar with vertical controls.

**(b) Hauling Equipment.** The mixtures shall be transported to the laydown operation in trucks that have tight, clean, and smooth beds.

100

Truck beds may be treated with approved anti-adhesive agents. The truck beds shall be raised after application of non-foaming anti-adhesive agents to drain the liquids from the bed prior to HMA being loaded into the truck. An approved List of Anti-Adhesive Materials will be maintained by the Department.

Hauling equipment shall be equipped with a watertight cover to protect the mixture.

**(c) Laydown Equipment.**

110

**1. Paver.** The paver shall be self-propelled, and equipped with a material receiving system, and equipped with heated and vibrating screeds. The paver may also include automatic slope and grade controls, extendable screeds and extendable augers.

Automatic control devices shall be separated from the paver screeds, paver tracks or wheels and be capable of adjusting both sides of the screeds automatically to maintain a constant angle of attack in relation to the grade leveler device or grade line.

A grade leveling system may be used to activate the control devices on each HMA course, including matching lays. The leveling system shall be attached to the paver and operated parallel to the paver's line of travel.

120

Extendable screeds shall be rigid, heated, and vibrating, and be capable of maintaining the cross slope, and line and grade of the pavement, to produce uniform placement of the materials.

Auger extensions shall be used when required to distribute the HMA uniformly in front of the screed.

130

**2. Widener.** A device capable of receiving, transferring, spreading, and striking off materials to the proper grade and slope.

**3. Other Mechanical Devices.** Inaccessible or short sections of HMA may be placed with specialty equipment approved by the Engineer.

**(d) Compaction Equipment.** Compaction equipment shall be self-propelled, steel wheel or pneumatic tire types, in good condition, and capable of reversing direction without backlashing. All roller wheels shall be equipped with scrapers to keep the wheels

clean, have water spraying devices on the wheels, and steering devices capable of accurately guiding the roller.

140

1. **Tandem Roller.** A roller having two axles and a minimum mass (weight) of 9 Mg (10 T).

2. **Three Wheel Roller.** A roller having three wheels with a minimum bearing of 5.3 kg/mm (300 lb/in.) on the rear wheels. The crown of the wheels shall not exceed 63 mm (2.5 in.) in 5.5 m (18 ft).

A tandem roller which has a drive wheel bearing of no less than 5.3 kg/mm (300 lb/in.) may be used in lieu of the three wheel roller.

150

3. **Pneumatic Tire Roller.** A pneumatic tire roller shall have a minimum rolling width of 1.65 m (5.5 ft). The roller shall be equipped with compaction tires, minimum size 7:50 by 15, exerting a uniform, average contact pressure from 345 to 621 kPa (50 to 90 psi) uniformly over the pavement by adjusting ballast and tire inflation pressures. The wheels on at least one axle shall be fully oscillating vertically, and mounted as to prevent scuffing of the pavements during rolling or turning operations. Charts or tabulations showing the contact areas and pressures for the full range of tire inflation pressures and for the full range of tire loadings for each compactor shall be furnished to the Engineer.

160

4. **Vibratory Roller.** A vibratory roller shall be equipped with a variable amplitude system, a speed control device, and have a minimum vibration frequency of 2000 vibrations per min. A reed tachometer shall be provided for verifying the frequency of vibrations. A list of approved vibratory rollers will be maintained by the Department.

5. **Trench Roller.** A trench roller shall have a compaction wheel bearing of no less than 5.3 kg/mm (300 lb/in.).

6. **Specialty Roller/Compactor.** Inaccessible or short sections of HMA may be compacted with specialty equipment approved by the Engineer.

170

#### (e) Miscellaneous Equipment.

1. **Aggregate Spreader.** A spreader shall be self-propelled, pneumatic tired-motorized unit with a front loading hopper and a transportation system for distributing the aggregates uniformly across the pavement.

2. **Rotary Power Broom.** A motorized, pneumatic tired unit with rotary bristle broom head.

180

#### (f) Smoothness Equipment.

1. **Profilograph.** A profilograph is an instrument that very precisely measures the vertical irregularities of the pavement. The profilograph is constructed of a main frame approximately 7.5 m (25 ft) in length supported by wheeled carriages at either

190 end to establish a reference plane for a rolling straight edge. At the midpoint of the main frame is a profile wheel that is mechanically linked to a strip chart recorder. As the profilograph is pushed down the pavement, irregularities/deviations of the profile wheel from the reference plane established by the profilograph are shown on the strip chart recorder. The profilograph records the irregularities/deviations, pavement profile, on a continuous paper chart referred to as the profilogram.

2. **Straightedge - 4.9 m (16 ft).** A 4.9 m (16 ft) straightedge shall be a rigid beam mounted on two solid wheels on axles 4.875 m (16 ft) apart. The straightedge has a mounted push bar to facilitate propelling the device along or across the pavement. Tolerance points are located at the 1/4, 1/2, and 3/4 points and may be composed of threaded bolts capable of being adjusted to the tolerance required.

200 3. **Straightedge - 3 m (10 ft).** A 3 m (10 ft) straightedge is the same as a 4.9 m straightedge except that the wheels are mounted 3.048 m (10 ft) apart. A handheld rigid beam may be substituted.

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### **SECTION 400 -- ASPHALT PAVEMENTS**

#### **SECTION 401 -- QUALITY CONTROL/QUALITY ASSURANCE, QC/QA, HOT MIX ASPHALT, HMA, PAVEMENT**

##### **401.01 Description**

##### **401.02 Quality Control**

##### **401.03 Materials**

##### **401.04 Design Mix Formula**

##### **401.05 Volumetric Mix Design**

(a) Gradation Table for Design ESAL Equal To or Greater Than 10,000,000

(b) Gradation Table for Design ESAL Less Than 10,000,000

##### **401.06 Recycled Materials**

##### **401.07 Lots and Sublots**

##### **401.08 Job Mix Formula**

##### **401.09 Acceptance of Mixtures**

##### **401.10 General**

##### **401.11 Preparation of Surfaces to be Overlaid**

##### **401.12 Process Control**

##### **401.13 Weather Limitations**

##### **401.14 Spreading and Finishing**

##### **401.15 Joints**

##### **401.16 Density**

(a) Mainline ESAL Equal To or Greater Than 10,000,000

(b) Mainline ESAL Equal To or Greater Than 1,000,000 and Less Than 10,000,000

(c) Mainline ESAL Less Than 1,000,000

##### **401.17 Shoulder Corrugations**

(a) Formed Corrugations

(b) Milled Corrugations

##### **401.18 Pavement Smoothness**

##### **401.19 Adjustment Points**

(a) Mixture

(b) Density

1. Mainline ESAL Equal To or Greater Than 10,000,000

2. Mainline ESAL Equal To or Greater Than 1,000,000 and Less Than 10,000,000

(c) Smoothness

##### **401.20 Appeals**

- (a) Mixture
- (b) Density
  - 1. Mainline ESAL Equal To or Greater Than 10,000,000
  - 2. Mainline ESAL Equal To or Greater Than 1,000,000 and Less Than 10,000,000
- 401.21 Method of Measurement
- 401.22 Basis of Payment
- SECTION 402 -- HOT MIX ASPHALT, HMA, PAVEMENT
- 402.01 Description
- 402.02 Materials
- 402.03 Job Mix Formula
- 402.04 Mix Criteria
  - (a) Composition Limits for Base Mixtures
  - (b) Composition Limits for Intermediate Mixtures
  - (c) Composition Limits for Surface Mixtures
  - (d) Composition Limits for HMA Rumble Strip Mixtures
  - (e) Composition Limits for HMA Wedge and Leveling Mixtures
- 402.05 Recycled Materials
- 402.06 Acceptance of Mixtures
- 402.07 Preparation of Mixtures
- 402.08 General
- 402.09 Preparation of Surfaces to be Overlaid
- 402.10 Weather Limitations
- 402.11 Spreading and Finishing
- 402.12 Joints
- 402.13 Compaction
- 402.14 Low Temperature Density Requirements
- 402.15 Shoulder Corrugations
  - (a) Formed Corrugations
  - (b) Milled Corrugations
- 402.16 Pavement Smoothness
- 402.17 Method of Measurement
- 402.18 Basis of Payment
- SECTION 403 -- COLD MIX ASPHALT, CMA, PAVEMENT
- 403.01 Description
- 403.02 Materials
- 403.03 Weather Limitations
- 403.04 Equipment
- 403.05 Preparation of Mixtures
- 403.06 Preparation of Subgrade or Base
- 403.07 Spreading Mixture
- 403.08 Curing
- 403.09 Compaction
- 403.10 Surface Tolerances
- 403.11 Method of Measurement
- 403.12 Basis of Payment
- SECTION 404 -- SEAL COAT
- 404.01 Description
- 404.02 Asphalt Material
- 404.03 Cover Aggregate
- 404.04 Weather Limitations
- 404.05 Equipment
- 404.06 Preparation of Surface
- 404.07 Applying Asphalt Material
- 404.08 Application of Cover Aggregate
- 404.09 Method of Measurement
- 404.10 Basis of Payment
- SECTION 405 -- PRIME COAT
- 405.01 Description

- 405.02 Asphalt Material
- 405.03 Cover Aggregate
- 405.04 Weather Limitations
- 405.05 Equipment
- 405.06 Preparation of Surface
- 405.07 Application of Asphalt Material
- 405.08 Cover Aggregate
- 405.09 Method of Measurement
- 405.10 Basis of Payment

SECTION 406 -- TACK COAT

- 406.01 Description
- 406.02 Asphalt Material
- 406.03 Equipment
- 406.04 Preparation of Surface
- 406.05 Application of Asphalt Material
- 406.06 Method of Measurement
- 406.07 Basis of Payment

SECTION 407 -- DUST PALATIVE

- 407.01 Description
- 407.02 Asphalt Material
- 407.03 Weather Limitations
- 407.04 Equipment
- 407.05 Preparation of Surface
- 407.06 Application of Asphalt Material
- 407.07 Method of Measurement
- 407.08 Basis of Payment

SECTION 408 -- EQUIPMENT

- 408.01 Production, Transportation, and Laydown of Asphalt Mixtures

- 408.02 Mixing Plant

- (a) HMA Mixing Plant

- 1. Plant Inspection
    - 2. Proportioning Systems
    - 3. Material Storage
      - a. Aggregates
      - b. Asphalt
    - 4. Aggregate Feed System
    - 5. Drier Unit
    - 6. Dust Collector
    - 7. Mixing Unit
    - 8. Mix Load-out Scales
    - 9. Hot Surge Bins
    - 10. Sampling Point Requirements

- (b) CMA Mixing Plant

- 408.03 HMA Laydown Operations

- (a) Distributor

- (b) Hauling Equipment

- (c) Laydown Equipment

- 1. Paver
    - 2. Widener
    - 3. Other Mechanical Devices

- (d) Compaction Equipment

- 1. Tandem Roller
    - 2. Three Wheel Roller
    - 3. Pneumatic Tire Roller
    - 4. Vibratory Roller
    - 5. Trench Roller
    - 6. Speciality Roller/Compactor

- (e) Miscellaneous Equipment



1. Aggregate Spreader
2. Rotary Power Broom
- (f) Smoothness Equipment
  1. Profilograph
  2. Straightedge - 4.9 m (16 ft)
  3. Straightedge - 3 m (10 ft)

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